On the Production and Perception of Spanish Palatal Obstruents: An Acoustic Phonetic Study with Implications for Phonology, Dialectology, and Pedagogy

Manuel Díaz-Campos
Indiana University

Terrell A. Morgan
The Ohio State University

1. Introduction.

In his classic manual of phonetics, Tomás Navarro (1967) offers a detailed description of Spanish <y> syllable-initially in normative Peninsular pronunciation.[1] Whereas the affricate phone [ɟ] (Navarro's [ŷ]) is expected after nasals, laterals, and often after a pause, a voiced palatal slit fricative [ʝ] (Navarro's [y]) is advocated following all other phones, including in intervocalic environments. Special mention is made (p. 130) of the particular problem of English speakers in mastering this sound: "La articulación de la **y** normal española es, en efecto, algo más cerrada que la que se observa en ... ingl. *yes, young*; la diferencia se advierte especialmente en la pronunciación de los norteamericanos, los cuales, en palabras españolas como *ayer, raya, mayo*, etc., pronuncian una *y* cuyo timbre resulta, en general, bastante más relajado y abierto que aquel a que el oído español se halla acostumbrado."

The present paper is just one part of a larger study, still in progress, which brings to the table an array of phonetic details that add to our understanding of the behavior of <y> on four fronts: (1) a comparison of the production and perception of various palatal variants by native Spanish speakers and English-speaking students of the language; (2) the behavior of the palatal obstruent phoneme in other Spanish dialects, especially those in which the consonant is known to weaken or delete intervocalically (Lipski 1994); (3) resyllabification of the word *y* 'and' with a following vowel; and (4) resyllabification contexts in which word-final <y> is followed by a vowel.

We are not able, in a paper of this length and scope, to do justice to all aspects of the elusive <y> in question. We would therefore like to concentrate on one major area of investigation where we find ourselves able to make the most interesting contributions at this point. The data to be presented center around our pilot study of the perception by native and non-native speakers of the voiced palatal obstruent phoneme when it appears in intervocalic position (section 3). We follow up with a brief study of production by native speakers across dialects (section 4), as well as a look at implications for pedagogy (section 5). We begin with descriptions of variants of <y> found in the Spanish phonetics literature.

2. Descriptions of the palatal variants.

The above-mentioned contextual distribution of palatal consonant phones given in Navarro for normative pronunciation is uncontroversial. What does vary considerably from one description to another is the symbols used to refer to the glide, fricative, and affricate variants. As the table in (1) shows, at least six different symbols represent the palatal nonsibilant affricate in the twelve texts listed, and five different symbols are used for the fricative.

	High, front unrounded glide	*Voiced palatal non-sibilant fricative*	*Voiced palatal non-sibilant affricate*
Alba 1998	[j] [i̯]	[ǰ]	[ɟ]
Barrutia & Schwegler 1994	[i̯]	[ɏ]	[y̌]
Canfield 1981	[i̯]	[y]	[ŷ]
Contreras & Lleó 1982	[y]		[ǰ]
Dalbor 1997	[i̯]	[y]	[ŷ]
Lipski 1994	[i̯]	[y]	[ŷ]
Navarro Tomás 1967	[j] [i̯]	[y]	[ŷ]

Núñez Cedeño & Morales-Front 1999	[j]	[y]	[y̌]
Quilis & Fernández 1979	[j]	[ǰ]	[ɟ]
Quilis 1981	[j] [i̯]	[ǰ]	[dʒ]
Teschner 1995	[j]	[j]	[ĵ]
Whitley 1986	[j]	[ɟ]	[ǰ]

(1) Symbols representing Spanish palatal non-sibilant obstruents in twelve texts

We have chosen to represent these sounds with what we judge to be the closest IPA approximations, namely those listed in (2).

High, front unrounded glide	*Voiced, palatal non-sibilant fricative*	*Voiced, palatal non-sibilant stop or affricate*[2]
[j]	[ʝ]	[ɟ]

(2) Symbols representing Spanish palatal non-sibilant obstruents in the present paper

Complicating the allophonic distribution alluded to above and rewritten in (3) for ease of exposition are several dialectal variations in the pronunciation of the palatal obstruents.

(3) Distribution of palatal obstruent phones
[ɟ] after pause, nasal, or lateral
[ʝ] everywhere else

These dialectal and idiolectal variations include the use of sibilants [ʒ] ([ž]) and/or [ʃ] ([š]) characteristic of so-called *žeísmo* and the appearance of [ʝ] and [ɟ] in free variation. The dialectal phenomenon of interest to us here, however, is a consonant weakening process common in Guatemala, Honduras, El Salvador, Nicaragua, and Costa Rica, and parts of Mexico and other countries (Canfield 1981, Lipski 1994). In these regions, the otherwise

fricative consonant weakens to a glide intervocalically, turning *mayo* into [majo] (=[mai̯o]) and *pollo* into [pojo] (=[poi̯o]).

In contact with a front vowel, the weak palatal tends to disappear altogether in these dialects, giving rise to pronunciations such as *ea, estrea, cae* for *ella, estrella, calle.* The stigma associated with this phenomenon has further affected Central American pronunciation by creating hypercorrected forms that are not uncommon: *rí*[ʝ]*o* for *río, veni*[ʝ]*a* for *venía* , etc. Given the apparent similarities between the weakening and loss of the palatal consonant in certain dialects and in the Spanish as a Second Language classroom, we decided to explore the phenomenon further from a perceptual, production, and pedagogical point of view.

3. Perception study.

Our main focus has been an experiment on the perceptual distinction between the front glide, the voiced palatal non-sibilant fricative, and the voiced palatal non-sibilant affricate by native speakers of Spanish and non-native speakers who speak English as a first language. Our purpose is to identify the threshold of phonemic distinctions between the segments under study for native and non-native speakers. In order to achieve this goal, we artificially created a set of finely varying but contextualized phones that range from clearly semivocalic to strident obstruent, and have enlisted native and non-native speakers of Spanish to identify random tokens as meeting, or not, their own standard for "acceptable" pronunciation of Spanish intervocalic <y>. The non-native speakers are English-speaking students of Spanish at varying levels of proficiency, but mostly at an intermediate level: Spanish majors and minors in their first year of courses in the actual major curriculum. The native Spanish speakers are of two types: those from dialects characterized by a weakened palatal (e.g. Central America, Northern Mexico, and the Northern Peruvian coast), and those from dialects in which the intervocalic palatal is unmistakably consonantal and resists effacement (e.g. Spain, Central Mexico, and the Caribbean).

3.1. Methodology.

The subjects in this study were 30 speakers from 3 different groups. The first group includes 5 speakers from non-weakening dialects in which intervocalic <y> (or <ll>) is produced as a palatal fricative or affricate sound, The second group consists of 5 speakers from weakening dialects in which intervocalic <y> (or <ll>) is produced with less constriction and, in many instances, vocalizes or deletes. The third group includes 20 native English speakers who study Spanish as a second language. These Spanish students have an intermediate level of proficiency. At the time this experiment took place, all the students were enrolled at The Ohio State University and registered for Spanish 404, an intermediate-level pronunciation class.

3.1.1. Stimuli

We created 17 targets ranging from clearly semivocalic to strident obstruents. There were two sets of targets: natural and synthesized. The term natural refers to stimuli produced by a native speaker manipulating consonant constriction and vowel duration. A description of the natural targets is found in (4).

Target	*Vowel duration*	*Consonant constriction*
millaN_1[3]		80ms
millaN_2		40ms
míaN_3	433ms	
míaN_4	361ms	
míaN_5	264ms	

(4) Description of the target words *milla/mía* produced with different vowel duration and consonant constriction.

The chart in (4) shows the characteristics of the 5 natural targets included in this investigation. The first two targets differ in the duration of the consonantal constriction found intervocalically. Target 1, *millaN_1*, has a consonantal constriction of 80ms, while in target 2, *millaN_2*, it lasts 40ms. The last three targets have no consonantal constriction and differ in their vowel duration. In target 3, *míaN_3*, the vowel has a duration of 433ms. In the case of *míaN_4*, the segment [í] lasts 361ms. In the third target, *míaN_5*, the vowel [í] is 264ms long. As we can see, the words *milla* 'mile' and *mía* 'mine [fem sg]' constitute a contrastive pair. We have decided to manipulate consonantal constriction and vowel duration in order to study the threshold at which native (from both weakening and non-weakening dialects) and non-native speakers identify a consonant in these contexts.

The synthesized targets were produced by the MBROLI speech synthesizer (Dutoit 1996). The inclusion of synthesized targets allows us to control other possible factors influencing the perceptual task proposed in this research. As explained above, vowel and consonantal duration were manipulated in two sets of synthesized targets. The first one included the words *milla* 'mile' and *mía* 'mine' and the second one *pilla* 'catch [3rd sg pres indic]' and pía 'chirp [3rd sg pres indic]'. The chart in (5) presents the description of synthesized targets in which vowel duration was manipulated and (6) presents the description of the synthesized targets in which duration of the consonantal constriction was manipulated. In (5), we see that the duration of the vowel [í] was increased from a mere 150ms to 300ms for each of the words. Since three different vowel durations were included for each word (150ms, 200ms, and 300ms), six targets were created using the words *mía* 'mine' and *pía* 'chirp'.

Target	*Vowel duration*
mía(150)S_6	150ms
mía(200)S_7	200ms
mía(300)S_8	300ms
pía(150)S_10	150ms
pía(200)S_11	200ms
pía(300)S_11	300ms

(5) Description of the synthesized targets (Vowel duration)

The first step in creating the targets with different consonantal constriction was to measure the default consonantal constriction duration according to the MBROLI speech synthesizer. The default duration was 80ms and, using this as our point of departure for a complete, synthetic, intervocalic palatal consonant, we chose to reduce the consonantal constriction by 20ms for each successively less consonantal target. The different consonantal constriction durations created were as follows: 80ms, 60ms, 40ms, 20ms, and 0ms, the last figure representing no constriction whatsoever.

Target	*Duration of consonantal constriction*
pí(0)aSM_13	0ms
pí(20)aSM_14	20ms
pí(40)aSM_15	40ms
pí(60)aSM_16	60ms
pillaSM_17	80ms
millaSM_9	80ms

(6) Description of the synthesized targets (Consonant constriction)

3.1.2. Task

The subjects worked individually at computer stations in a media laboratory on the Ohio State campus.[4] They followed the instructions on the screen and clicked on the mouse when they were ready to hear each token in turn. Subjects listened to the 17 targets and matched the word that they heard with the best option provided for each item in a multiple-choice format. Although they proceeded at their own pace through the tokens, they were allowed to click on each sound file only once, after which time they were required to select the best match.

3.2 Results and Discussion.

The results of this investigation are based on the answers provided by 30 speakers. We compared perceptual differences among three groups: native Spanish speakers from non-weakening dialects, native Spanish speakers from weakening dialects, and non-native speakers of Spanish who speak English as a first language. We turn first to subjects' perception of the natural targets, which differ in consonantal constriction and vowel duration.

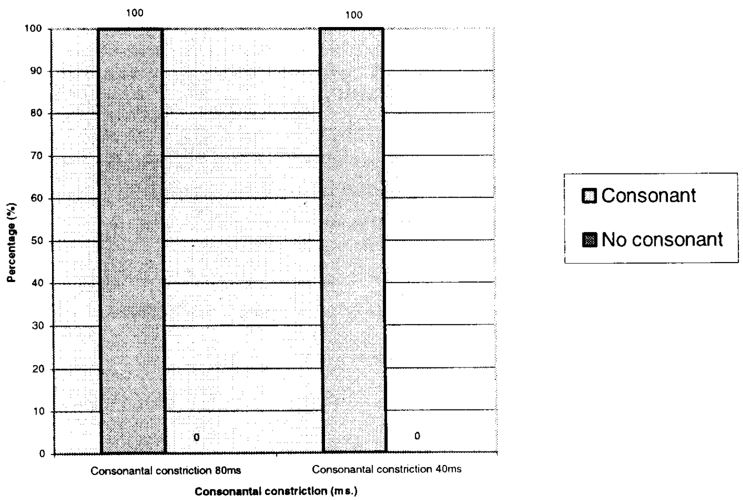


Figure 1: Percentage of subjects who perceived a given constriction as a palatal consonant (non-weakening dialects).

Figure 1 shows the results for consonant constriction in the sample of speakers from non-weakening dialects. As we can see, all informants perceived a consonant regardless of the 40ms of difference between *target 1*, produced with a constriction of 80ms, and *target 2*, in which constriction lasts 40ms.

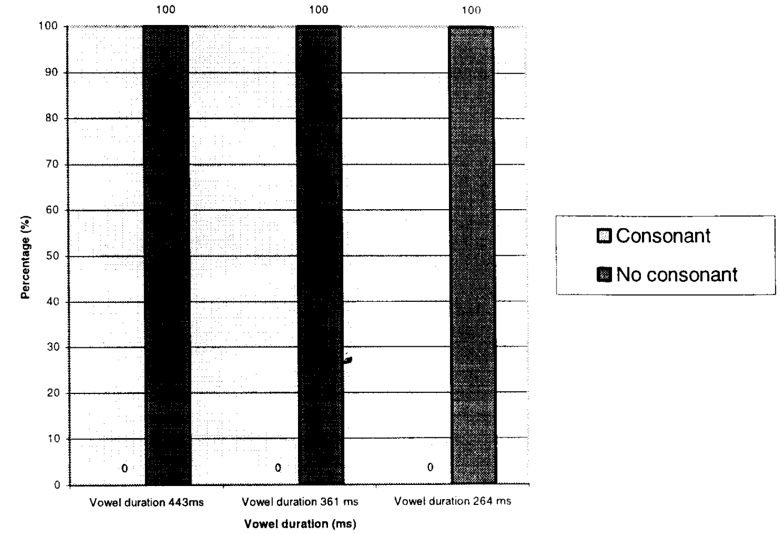


Figure 2: Percentage of subjects who perceived different degrees of vowel duration as a palatal consonant (non-weakening dialects).

According to the results in figure 2, non-weakening dialect speakers do not confuse a long vowel with the presence of a consonant in any of the conditions presented. The production of a consonantal constriction is necessary for the identification of the palatal consonant in this group of subjects.

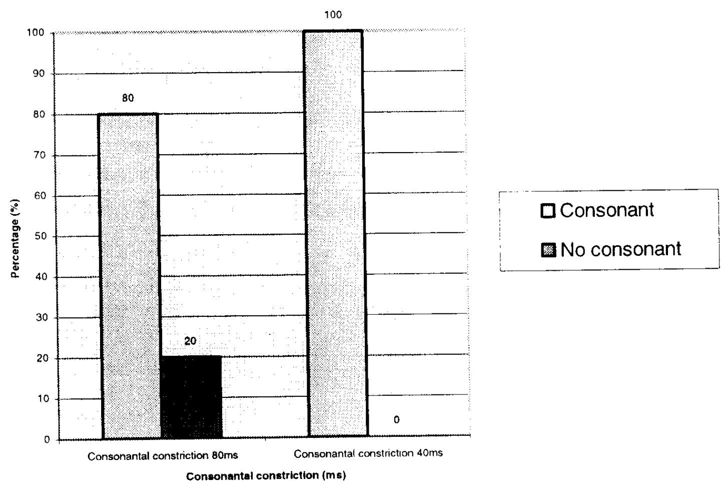


Figure 3: Percentage of subjects who perceived a given constriction as a palatal consonant (weakening dialects).

Speakers from weakening dialects are less categorical in their perception. As we see in Figure 3, 20% of the speakers did not recognize a consonant when the constriction was 80ms, the longest consonantal constriction included in the case of the natural targets. This contrasts with the results for non-weakening dialects in which there was no confusion in the perception of a segment in the two consonantal constrictions presented. This seems to reflect the pattern of variation that has been reported (Canfield 1981, Lipski 1994) in the production of the palatal fricative in the weakening dialects.

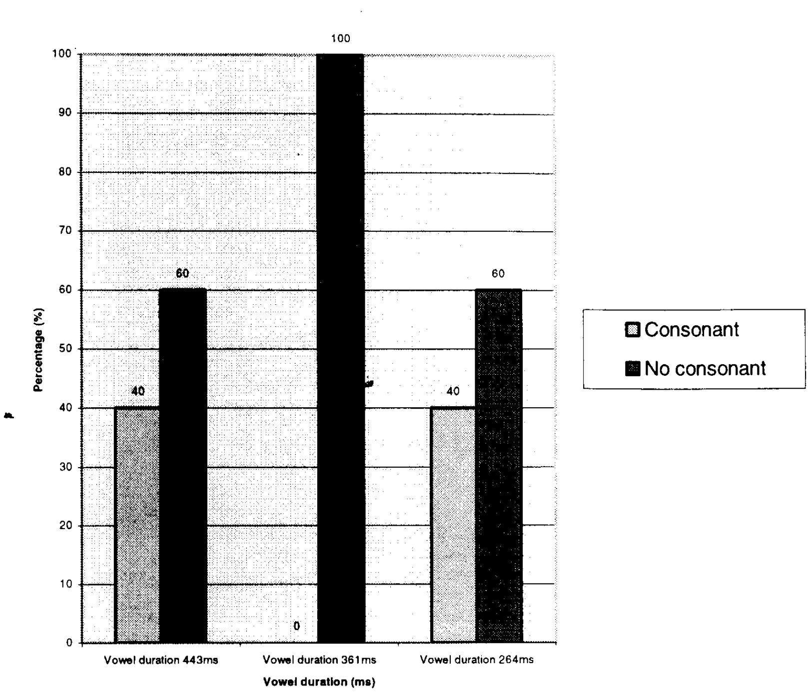


Figure 4: Percentage of subjects who perceived different degrees of vowel duration as a palatal consonant (weakening dialects).

Figure 4 shows that when vowel duration is 443ms and 264ms 40% of the weakening dialect informants tend to perceive a consonant segment. In contrast, the speakers did not perceive a consonant when the vowel was 361ms long. Once again, these findings indicate that the pattern of variation in the production of the fricative palatal in weakening dialects is also found in the perception of it.

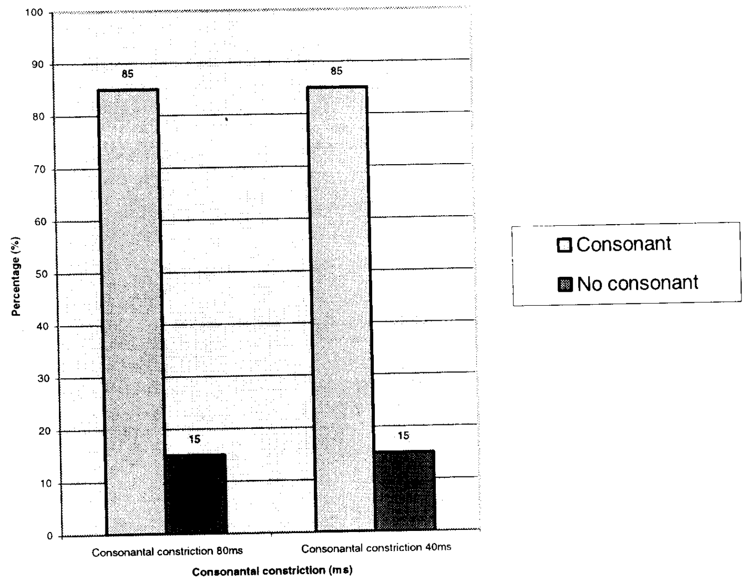


Figure 5: Percentage of subjects who perceived a given constriction as a palatal consonant (American students).

In the case of American students of Spanish, the findings in Figure 5 show that in the two conditions of consonantal constriction examined, 85% of the students perceived a segment. American student's perceptual behavior for consonantal constriction does not exhibit striking differences with respect to the perceptual behavior described for native speakers above.

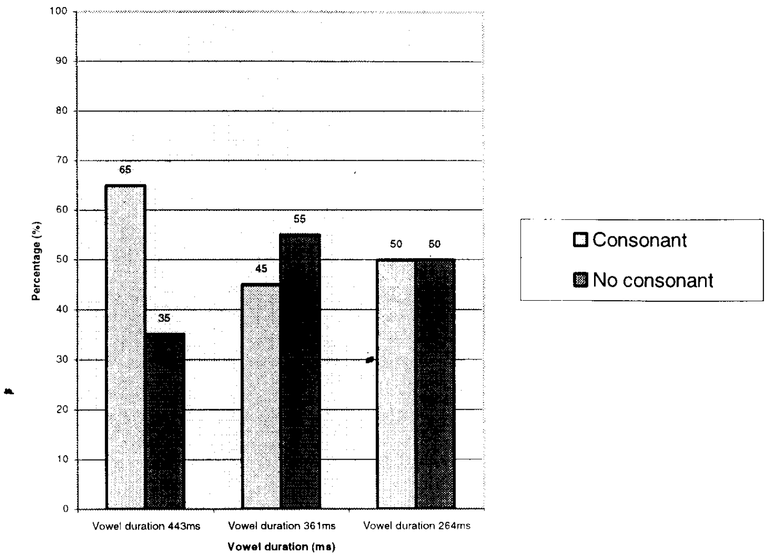


Figure 6: Percentage of subjects who perceived different degrees of vowel duration as a palatal consonant (American students).

As can be seen in figure 6, the results reveal more variation according to vowel duration in the case of American students. This means that an increase of vowel duration tends to trigger the perception of a consonant for non-native speakers. This pattern of perception in non-native speakers is in contrast with the one found for native speakers of non-weakening dialects for whom an increase of vowel duration is never perceived as a consonant when considering the natural targets.

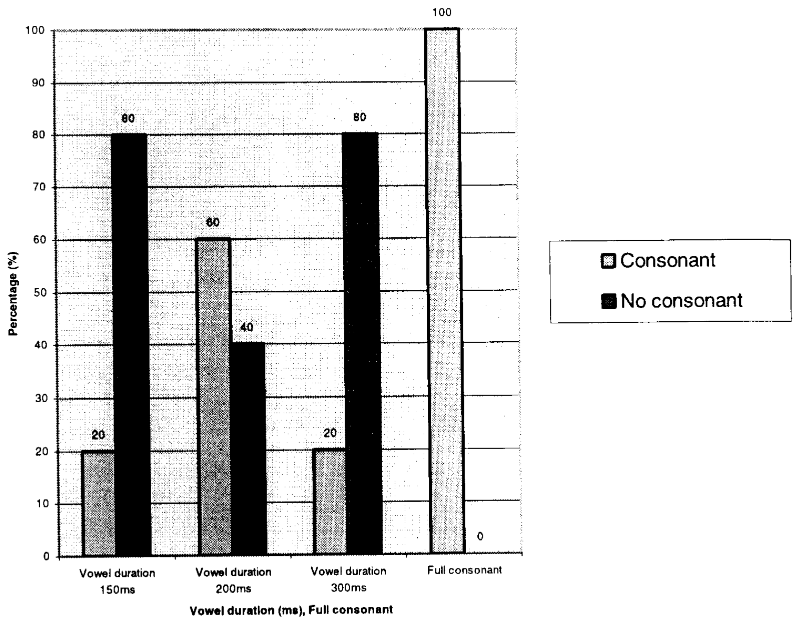


Figure 7: Percentage of subjects who perceived different degrees of vowel duration in the synthesized targets as a palatal consonant (non-weakening dialects).

In Figure 7, the bar on the far right shows the results for the default production of the word *milla* 'mile' with a full consonant; 100% of the speakers of non-weakening dialects identified the consonant in this case. When synthetically manipulating the duration of the vowel, we found that if the vowel was 200ms in duration the speakers tended to perceive a consonant. Nevertheless, this result is not consistent with what we found when the vowel is 300ms in duration, where non-weakening dialect speakers did not perceive a consonant 80% of the time. In contrast with what we found when analyzing the set of natural targets, it appears here that vowel duration can be one of the cues used to identify a consonant in synthesized speech.

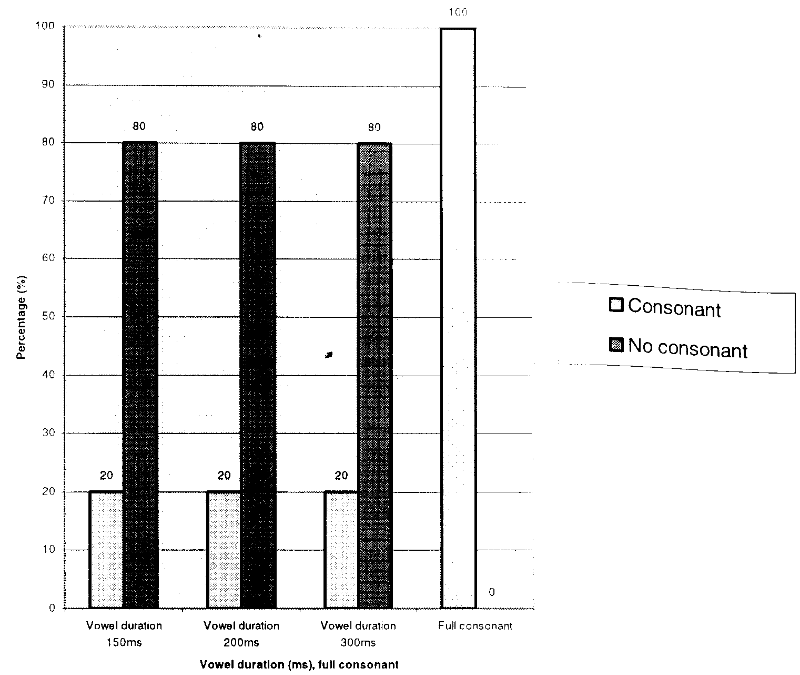


Figure 8: Percentage of subjects who perceived different degrees of vowel duration in the synthesized targets as a palatal consonant (weakening dialects).

Figure 8 shows a consistent pattern for 20% of the weakening-dialect speakers where vowel lengthening is perceived as a consonant. In the case of the full consonant (bar on the far right), the weakening dialect speakers perceived the consonant 100% of the time, just as the non-weakening dialect speakers did.

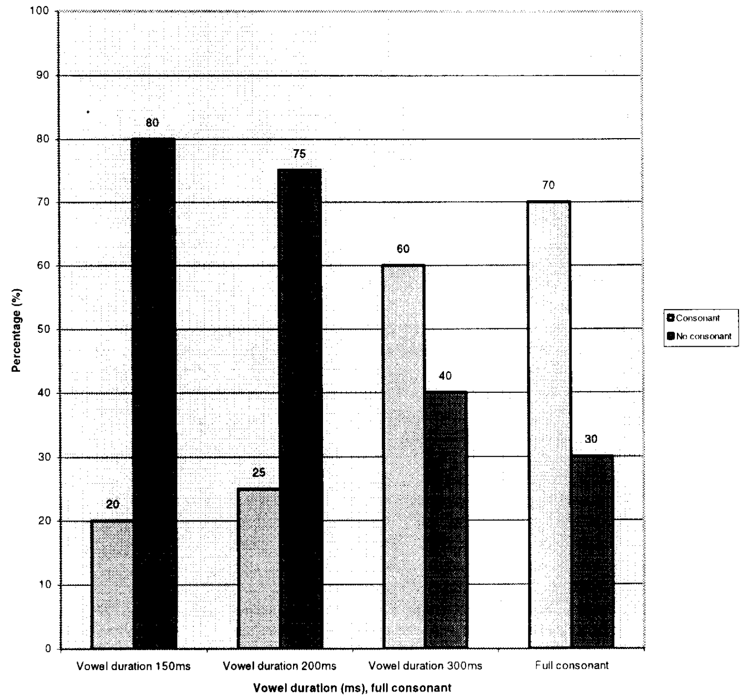


Figure 9: Percentage of subjects who perceived different degrees of vowel duration in the synthesized targets as a palatal consonant (American students).

The results in Figure 9 illustrate that fully 60% of the English-speaking students of Spanish identified a consonant when the vowel was 300ms long. In this case, vowel duration has a stronger effect for non-native speakers than for native speakers in the identification of the consonant. On the other hand, 30% of the American students did not perceive a consonant in the case where the full consonant was produced. This pattern of perception contrasts with the one observed among non-weakening and weakening dialect speakers for whom recognition of the consonant is categorical.

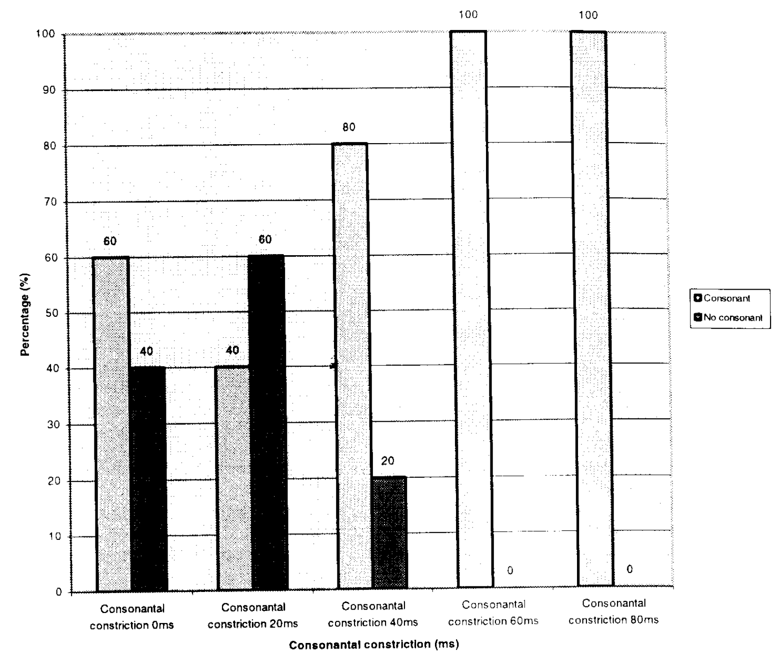


Figure 10: Percentage of subjects who perceived different degrees of constriction in the synthesized targets as a palatal consonant (non-weakening dialects).

The results in Figure 10 reveal that a consonantal duration of 60ms was the threshold for recognizing [ʝ] categorically in the case of the non-weakening dialect speakers. When the consonantal constriction was 40ms, 80% of the speakers perceived a consonant. In the rest of the conditions presented, the subjects did not perceive the consonant with the same level of certainty.

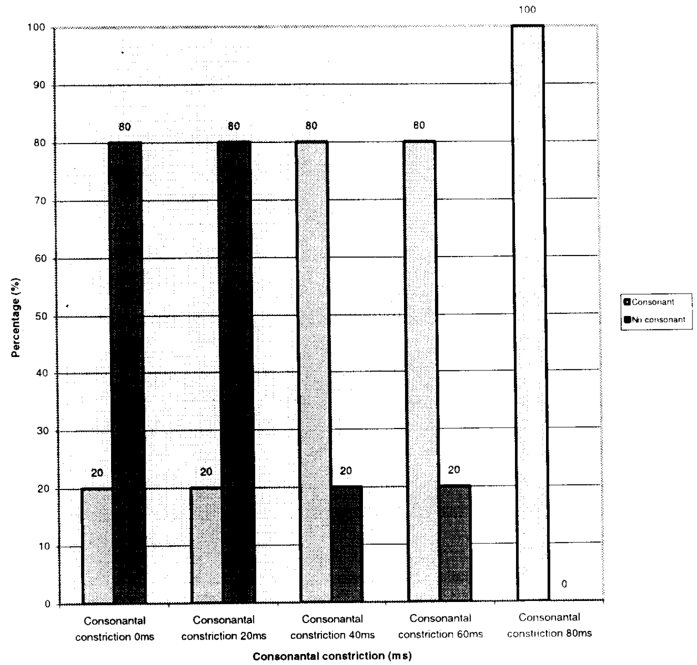


Figure 11: Percentage of subjects who perceived different degrees of constriction in the synthesized targets as a palatal consonant (weakening dialects).

Figure 11 shows the results regarding the duration of consonantal constriction for speakers of weakening dialects. The threshold for recognizing [ʝ] categorically is when the consonantal constriction duration is 80ms. Eighty percent of the speakers perceived a consonant when the consonantal constriction duration was 40ms and 60ms. This pattern of perception indicates a certain degree of variation on the part of informants from weakening dialects.

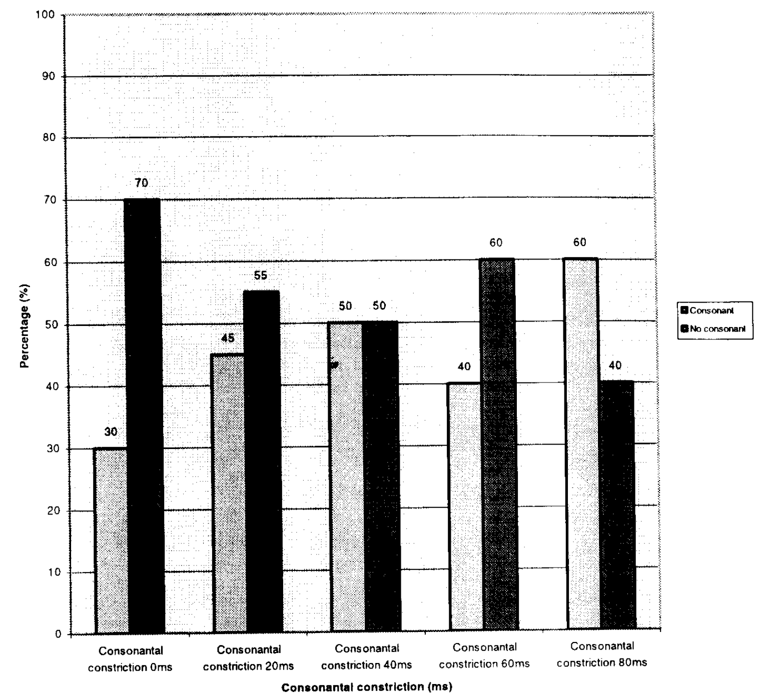


Figure 12: Percentage of subjects who perceived different degrees of constriction in the synthesized targets as a palatal consonant (American students).

For the American students, the duration of consonantal constriction is not a perceptual cue for identifying the palatal fricative [ʝ]. Figure 12 illustrates that only 60% of the speakers perceived a consonant when the constriction was 80ms long (that is, when it was completely intact). As we discussed above, English-speaking students tend to equate vowel duration with the presence of a consonant. For native speakers, however, the fundamental cue for identifying [ʝ] is the consonantal constriction.

Needless to say, we have only worked here with vowel duration, on the one hand, and the duration of consonant constriction, on the other. There are undoubtedly other acoustic cues that may affect the perception of intervocalic palatals in actual speech.

4. Production study.

The results of our study of perception, as described above, allow us to characterize our Central American Spanish speakers in three ways vis-à-vis the other two groups. First of all, they are rarely unanimous in their evaluation of nonce tokens as having an intervocalic consonant or not—unlike speakers in the non-weakening group, who are completely in agreement the vast majority of the time. Secondly, they do, nevertheless, usually identify unadulterated cases of intervocalic palatals, unlike the non-natives who largely did not perceive them. Lastly, in spite of their general lack of unanimity, the Central Americans patterned more like the other native speakers than they did the non-natives, and were less distracted by vowel length than were their non-native counterparts.

In very important ways, then, we see the Central Americans having less difficulty with the perception task than we might have imagined. In order to follow up on this finding, we have begun a second study, in which we seek to determine to what extent their production coincides with this largely intact ability to perceive intervocalic palatal consonants. In our production study, we analyze recordings of both free and directed speech by native Spanish speakers from various dialect areas, all characterized by *yeísmo* but which allegedly differ in their treatment of intervocalic <y>.

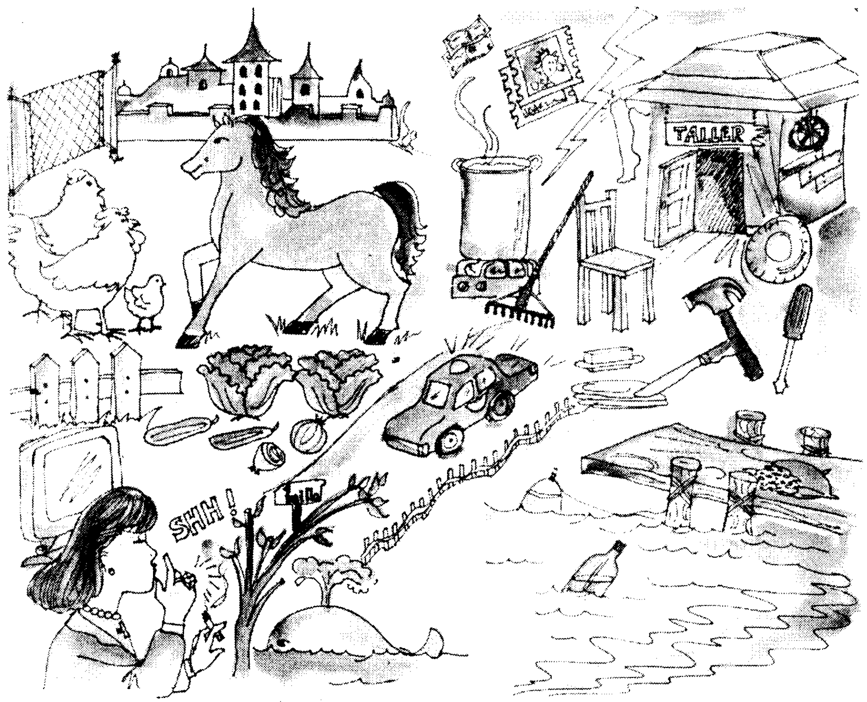
4.1. Methodology.

Three speakers from non-weakening dialects and two speakers from weakening dialects have been interviewed so far for the production phase of this study. The interview consists of two tasks. In the first, subjects read a passage in which the voiced palatal obstruent appears after a pause, nasal consonant, lateral consonant, and vowel. One representative text appears in (7).

(7) Representative text read by native speakers in production study

"Yema de huevo" dice el título que lee María. María se come una yema de huevo todas las mañanas con su batido de vegetales para tener energía. Cien yemas no serían suficientes para levantarle el ánimo al hermano de María. Habría que darle mil yemas para que fuera a su trabajo con mucha energía.

The second task consists of speech elicitation using an illustration containing objects whose names bear the target sound. The picture, which appears in (8), was commissioned expressly for this purpose and illustrates a large set of words, listed in (9), with the intervocalic palatal obstruent.[5]



(8) Illustration used in production task

(9) Words illustrated in (8)

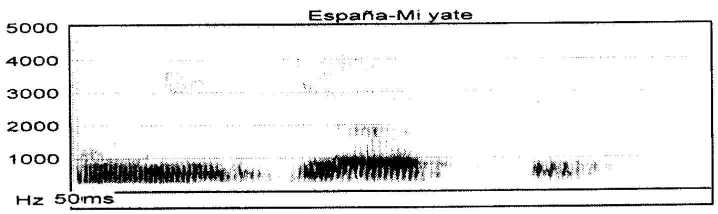
Ballena, billetes, botella, boya, caballo, calla, castillo, cebolla, cuchillo, destornillador, gallina, malla, mantequilla, martillo, muelle, olla, pantalla, patrulla, pepinillo, pollito, rastrillo, rayo, repollo, rodilla, sellos, silla, taller, valla.

Subjects were recorded by a native Spanish speaker as they read the texts and described what they saw in the picture. Other readings and spontaneous conversation had been recorded previously and provided further input to the production study.[6] Forms with intervocalic <y> and <ll> were isolated and analyzed with the phonetics software package PCquirer, which performs acoustical analyses on recorded speech.[7]

Several students from the intermediate-level course in Spanish pronunciation were also recorded as they pronounced words of the type found in (9). Their pronunciations were also subjected to PCquirer analysis.

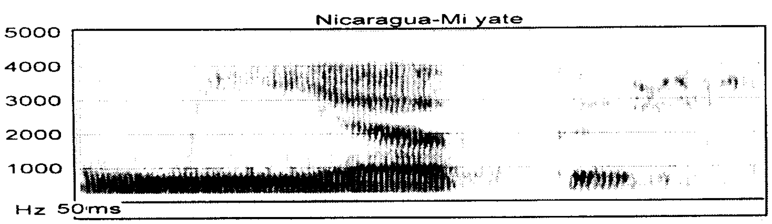
4.2. Preliminary results and discussion.

Acoustical analysis of the productions of non-weakening dialects shows a pattern similar to the one described by Navarro (1967) in some cases (that is, the distribution stated in (3)), and more liberal use of the affricate for others. In all cases, the palatal was clearly consonantal, as illustrated by the spectrogram for *Mi yate* as pronounced by a speaker from Madrid, given in (10).



(10) *Mi yate* as pronounced by a speaker from Madrid

In the case of the weakening dialect speakers, the acoustic analysis showed the production of a vocalized consonant where a fricative sound would be expected in the non-weakening dialects. In the spectrogram for a Nicaraguan pronunciation of *Mi yate* given in (11), the formants of the high front vowel [i] merge into those of the vowel [a] without the intervening friction we see in (10). This attests to the vocalization of the initial segment of *yate*.



(11) *Mi yate* as pronounced by a speaker from Nicaragua

5. Some implications for pedagogy.

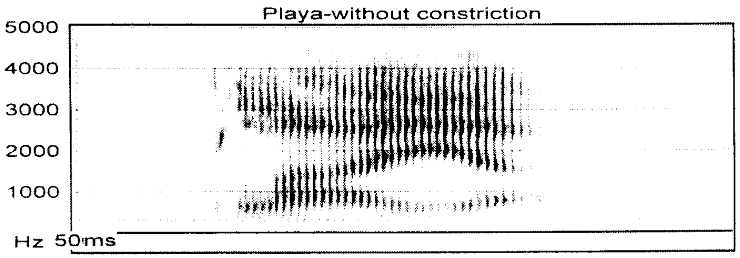
The inability of English-speaking students to perceive the fricative [ʝ] is not shared by native Spanish speakers (even those from weakening dialects). Our own production analysis as well as those of Navarro and others confirm, moreover, that a very real difference exists between the Spanish syllable-initial <y> and the English /y/ of *yes*. We might legitimately ask how important this difference is in the teaching of Spanish pronunciation to English speakers. Consider the points of view in (12) taken from two of the most popular phonetics textbooks in the U. S. college market.

(12)(a) "Both Spanish fricatives [y] and [ž] have almost exact equivalents in English, as in the words *yolk* and *measure*, respectively" (Dalbor 1997: 218).

(b) "En el habla familiar y espontánea la /y/ se pronuncia más suave, a veces debilitándose aún más que [ƀ, đ, ǥ]. Los alófonos débiles son idénticos a la semiconsonante del inglés en palabras como *you, yes*" (Barrutia & Schwegler 1994: 125).

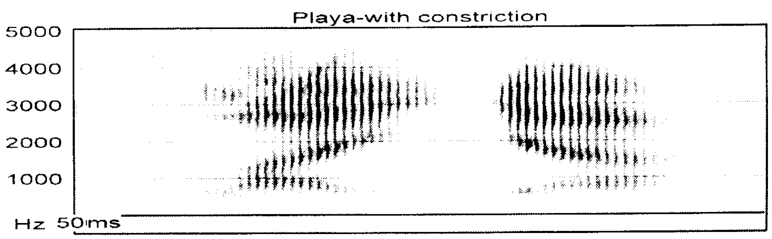
Needless to say, we disagree completely with their assessment. English-speaking students come to the task of language learning with a decided handicap in terms of both the perception and the production of the Spanish palatal obstruents, and their substitution of the glide from English *yes* will surely be noticed by the vast majority of native speakers of the language. Fortunately, although the voiced nonsibilant palatal fricative of most Spanish dialects does not exist with any regularity or systematicity in English, pedagogical and acoustic phonetic devices can be used to train students to appreciate and imitate the sound that is foreign to them.

As in all skill development, a progression of exercises is important, and in the pronunciation classroom such a progression generally takes us from basic recognition, through isolated sound production and guided elicitation of more complex structures, all the way to spontaneous speech in which the desired L2 sounds appear in the appropriate contexts. Along the way, we would maintain that a visual comparison of the palatal fricative vs. the high front glide might be in order; indeed, this approach has helped our own students to appreciate the additional effort they need to put forth in order to approximate native pronunciation. Consider, for example, the student whose pronunciation of *playa* was without palatal constriction, as illustrated by the spectrogram in (13).



(13) Non-native pronunciation of *playa* by an English-speaking student.

Upon seeing the contrast provided by a similar spectrographic visualization of native speech, our student was able to manipulate his own speech and ultimately produce the spectrogram in (14) and, of course, the corresponding native-like pronunciation.



(14) Native-like pronunciation of *playa* by an English-speaking student

We were impressed by the importance of immediate visual feedback via the spectrograms of PCquirer in the classroom and would encourage similar uses of technology and attention to phonetic detail.

6. Conclusion.

Our results fill a gap in what is known about the dialectal behavior of Spanish <y>, not so much in terms of production but as regards its perception. Indeed, the failure of certain speakers to produce the intervocalic consonant has been well documented in the literature, but only now can we add to such descriptions the additional fact that native speakers of non-weakening and weakening varieties appear to perceive intervocalic palatal obstruents whether they produce them or not. In this way, our research contributes to a greater understanding of the phonological makeup of the Spanish language.

At the same time, we have shown the perspective of the American student of Spanish to be very different, since English speakers do not distinguish

regularly between the front glide and the palatal fricative in perception tests. We suggest that teachers and students of Spanish pronunciation will benefit from a detailed description of the native phonetic targets and a better appreciation of how it is, exactly, that English speakers miss the mark.

Notes.

1. We have refrained from referring here to the "phoneme /y/" (or /ʝ/ or /ɟ/ or whatever) so as to be faithful to Navarro's phonetically detailed but phonologically atheoretical description. The choice of a particular phonemic representation would force us to make assumptions about underlying feature specification that are irrelevant to the study at hand and that would unnecessarily complicate an already challenging scenario.

While our study includes all instances of the palatal obstruent phoneme—whether the spelling is <y>, <ll>, or <hi>--Navarro assumes *lleísmo* (and, specifically, a lateral pronunciation for <ll>) in the educated standard Castilian pronunciation he prescribes in his manual.

2. Ladefoged (1993:162) states: "Palatal stops are slightly less common [than palatal nasals]. They occur, for example, in the Akan languages of Ghana. Because of the shape of the roof of the mouth, the contact between the front of the tongue and the hard palate often extends over a fairly large area. As a result, the formation and release of a palatal stop is often not as rapid as in the case of other stops, and they tend to become affricates".

3. In the case of millaN_1, the consonantal constriction lasts 80ms, while that of millaN_2 lasts 40ms. The name of the files are iconic since the first five letters refer to the word *milla* 'mile', the symbol N indicates that this is a natural target, and the number 1 is the unique identification number of the target.

4. Software for this experiment was developed by OSU's Humanities Information Systems. For this we wish to acknowledge the generous support provided by Diane Dagefoerde and James Cheng.

5. The illustration was commissioned by Terrell A. Morgan as part of the *Electronic Catalogue of the Sounds of Spanish* and created by Neydée Pinzón.

6. These recordings were also developed as part of the *Electronic Catalogue* project and are available in part at:
<http://sppo.ohio-state.edu/faculty/morgan.3/sounds.html>.

7. To access more information about the PCquirer software, visit:
<http://www.sciconrd.com/multi.htm>.

References.

Alba, Orlando. 1998. *Los sonidos del español.* Santo Domingo: Soto Castillo.

Barrutia, Richard and Armin Schwegler. 1994. *Fonética y fonología españolas: Teoría y práctica.* 2nd ed. New York: Wiley.

Canfield, D. Lincoln. 1981. *Spanish Pronunciation in the Americas.* Chicago: University of Chicago Press.
Contreras, Heles and Conxita Lleó. 1982. *Aproximación a la fonología generativa: Principios teóricos y problemas.* Barcelona: Anagrama.
Dalbor, John B. 1997. *Spanish Pronunciation: Theory and Practice.* 3rd ed. Fort Worth: Holt, Rinehart and Winston.
Dutoit, Thierry. The MBROLA Project: Towards a Freely Available Multilingual Speech Synthesizer. Faculté Polytechnique de Mons (Belgium). <http://tcts.fpms.ac.be/synthesis/mbrola/>
Ladefoged, Peter. 1993. *A course in phonetics.* Fort Worth: Harcourt Brace Jovanovich College Publishers.
Lipski, John M. 1994. *Latin American Spanish.* London: Longman.
Navarro Tomás, Tomás. 1967. *Manual de pronunciación española.* 6th ed. New York: Hafner.
Núñez Cedeño, Rafael A. and Alfonso Morales-Front. 1999. *Fonología generativa contemporánea de la lengua española.* Washington: Georgetown University Press.
Quilis, Antonio and Joseph A. Fernández. 1979. *Curso de fonética y fonología españolas para estudiantes angloamericanos.* 9th ed. Madrid: CSIC.
Quilis, Antonio. 1981. *Fonética acústica de la lengua española.* Madrid: Gredos.
Teschner, Richard V. 1996. *Camino oral: Fonética, fonología y práctica de los sonidos del español.* New York: McGraw-Hill.
Whitley, M. Stanley. 1986. *Spansih/English Contrasts: A Course in Spanish Linguistics.* Washington, D.C.: Georgetown University Press.

Are Plurals Derived or Stored?

David Eddington
University of New Mexico

Patricia Lestrade
Mississippi State University

1. Introduction.

The ability to produce and comprehend human language involves at least two processes: the storage of units and the computations performed on those units. The role that storage and computation play in the processing of inflectional morphology is highly debated. At one end of the spectrum is the full storage model, which holds that all known words, whether morphologically complex or not, have separate entries in the mental lexicon (Jackendoff 1975, Manelis and Tharp 1977, Butterworth 1983, Bybee 1985, 1988, Rumelhart and McClelland 1986, McClelland 1988, Stemberger 1994, Rueckl, Mikolinski, Raveh, Miner, and Mars 1997). This position puts an enormous burden on memory, but entails little in the way of computation. Here computation is needed to handle only new items or those that are temporarily inaccessible from memory. At the other end of the spectrum is the full parsing model, which assumes that all complex forms are derived (Taft 1979, 1981, 1985, 1994). This model places a very minimal load on memory, but requires a great deal of computation.

Another approach, that combines both parsing and storage, is that of Schreuder and Baayen (1995). In their dual-route model, parsing and access to stored items function in parallel. That is, recognition is not uniquely a matter of full storage or full parsing, but a race between the two. If parsing is too time-consuming, access to the whole word entry will win the race. When parsing is time-efficient, access based on the constituent morphemes will take place. This model is not merely conceptual, but computational, since it involves an algorithm that is able to predict actual reaction times. In short, it is based on the idea that both full storage and parsing occur, and that for any given word, the most time-efficient method will be used.

In recent years, the tradeoff between computation and storage has focused on differences in the processing of regular versus irregular inflection. The model espoused by Pinker and his colleagues (Pinker and Prince 1988, 1994, Pinker 1991, 1997, Clahsen, Rothweiler, Woest, and Marcus 1992, Prasada and Pinker 1993, Marcus, Brinkmann, Clahsen, Wiese, Woest, and Pinker 1995, Ullman 1999) suggests that all irregularly inflected items are stored as whole units in the mental lexicon, while regular inflections have no individual representation.[1]